Illuminating Terahertz science

TerZ Director Professor Sergey Ganichev, and Professor Dieter Weiss, of the University of Regensburg, shed light on developments in the growing field of terahertz research…

The colour of light is determined by its wavelength or frequency, indicating how fast the associated electric field of the light wave changes direction. However, a large fraction of the electromagnetic spectrum is invisible to the human eye. This is also true for terahertz (THz) radiation corresponding to frequencies around 10^{12} (trillion) Hertz. Terahertz radiation has low energy and is thus biologically non-hazardous, penetrates conventionally opaque materials like textiles or organic tissue, and has a high chemical sensitivity due to molecule-specific absorption. Thus terahertz science and technology is a promising contemporary field of physics, with great prospects for progress in diverse scientific areas and a wide application potential in material characterisation, medicine, chemistry, environment monitoring, security, biomedical imaging, and chemical/biological sensors.

However, this frequency range, lying between microwave and optical frequencies, is only scarcely used – a consequence of the lack of commercially available solid state sources. Current research involves the search for and design of new sources and detectors of THz radiation as well as the use of THz light in various applications and basic research. The latter in particular is on the agenda of the Regensburg Terahertz Center (TerZ), though considerable effort is also assigned to pushing the technology forward.

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The laboratories of the Terahertz Center at Regensburg allow experiments at frequencies covering the near infrared (10^{14} Hz) to microwave radiation (10^{10} Hz) including the whole terahertz regime. Several laser and spectroscopic systems permit studies from low to ultra high radiation intensities. The objects of scientific interest are low-dimensional electron or hole systems, which can also be found in various transistor structures or in graphene, a novel and promising material for future electronics. Terahertz radiation allows for the exploration of the spin degree of freedom of the charge carriers, ie. the miniscule quantised magnetic moment that is attached to electrons. The spin together with the elementary charge constitutes the field of spintronics, which aims to use the spin of the charge carriers in electronics to achieve new functionalities.

TerZ is also part of the Regensburg Collaborative Research Center (SFB 689) funded by the German Research Foundation (DFG). An important goal of TerZ is fostering networks between various local groups and colleagues from all over the world interested in the experimental facilities of the centre. The cooperating laboratories have by now accumulated a vast amount of know-how based on the rich palette of available terahertz equipment. Most notable is an institutionalised cooperation between the Ioffe Institute and the St. Petersburg State Polytechnic University, as well as the Lomonosov Moscow State University, which is funded by the International Bureau of Germany's Federal Ministry of Education and Research (BMBF). The resulting establishment of the German-Russian Terahertz Centre is an important step in joining forces between Europe and Russia in the field of terahertz research.

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